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⑳ **Particulate trap.**

⑳ There is provided a co-current regenerable particulate trap for continuously separating particulates, e.g., carbonaceous particles and volatile components from a fluid stream, from a fluid stream which is characterized by a rotating trap member mounted for rotation in a flowing gas stream, e.g., an engine exhaust gas stream. The device is also characterized by a conduit confronting the rotatable trap member on the upstream side, and isolated from the particle-containing fluid, for directing a regenerating fluid through a portion of the rotatable trap member during rotation thereof to continuously regenerate said trap by removal of particles trapped therein, e.g., by burning in an oxygen-containing gas. The principal advantages of this device are that it makes possible continuous, as distinct from intermittent, removal of particles and regeneration of trapping device, and

enables better control of the regeneration temperature.

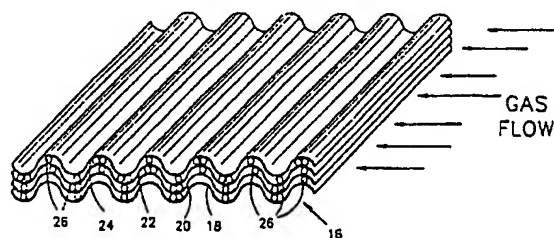


FIG. 3

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PARTICULATE TRAP

The present invention relates, as indicated, to a trap for collecting particles from a moving fluid, and more particularly, to a particulate trap for removing fine particles from a moving gas, e.g., carbonaceous particles from diesel exhaust gases.

BACKGROUND OF THE INVENTION AND PRIOR
ART

The art is replete with devices for removing solid or liquid particles from moving fluid (liquid or gas) streams ranging from filter paper and permeable solid members such as steel wool or glass wool, molybdenum fibers and ceramic fibers, to electroprecipitators, e.g., Cottrell precipitators. More recently with the growing concern over particulates in the air we breath, many developments have emerged. The present invention is principally concerned with removal of particles from exhaust gases from internal combustion and gas turbine engines.

Among the most visible offenders are diesel engines; automotive, marine, and stationary. Combustion is very often incomplete and disturbing black clouds of exhaust emanate from the exhaust stacks of such engines, particularly over-the-road trucks and buses. A considerable amount of effort has been expended to develop a satisfactory particulate trap for diesel engines. Reference may be had to commonly owned application Serial No. 769,710 filed 12 November 1985 in the name of Richard C. Cornelison for one form of particulate trap for diesel engines.

The principal problem with prior art devices for trapping particulates has been in respect of regeneration of the trap for continued use. Use for a period of time causes the trap to become clogged with particulates, and unless the filter is to be replaced as a unit, as water filters usually are, the particulate trap or filter must undergo regeneration or flushing.

In the case of diesel exhaust particulate traps, regeneration or flushing is currently done by splitting the exhaust line at a "Y" and sending exhaust through one leg of the "Y" for particle removal, while the other leg of the "Y" is connected to a regenerating fluid, e.g., air and fuel at a temperature sufficient to "light off" the accumulated carbon. The exhaust stream is alternated between the regenerated side of the "Y" and the clogged side of the "Y" as required and then collected by a suitable header or inverted "Y" for passage out the tail pipe.

The foregoing system is expensive and not entirely satisfactory because regeneration temperatures can reach 2400F° due to the exothermic potential of the carbon particles. The present invention solves this problem in an especially satisfactory way for the diesel engine.

Basically, it has been found that a very satisfactory particulate trap is provided by a rotary member rotating on an axis and disposed in intercepting relation with the flow of the exhaust gas. Generally, the diameter of the rotary member is greater than the diameter of the exhaust line in which it is inserted. A first segment of the "wheel" is open to the exhaust gas containing particulates, and a smaller second segment, isolated from the first segment, is adapted to receive a regenerating material, e.g., hot air or air and fuel. As the wheel rotates through the first segment, particles of carbonaceous material suspended in the exhaust are trapped by a specially configured member. As the wheel continues its rotation, it enters the isolated second segment and undergoes regeneration whereby the entrapped carbonaceous particles are burned off the trapping members and a fresh trapping section is again presented to the contaminated exhaust gases.

The trapping member is formed from catalyzed or non-catalyzed corrugated metal wire gauze, ceramics, or high temperature composites preferably in layers. In the case of layered materials several layers of such corrugated metal, or composites, are superimposed one on the other to build up a trapping segment or member. The layers are maintained in closely spaced relation. A convenient mode for spacing the layers is to apply a coating which tightly adheres to the surface and contains distributed therethrough temperature resistant particles of substantially uniform size, e.g., stainless steel particles, or particles of alumina, or zirconia particles. Alternatively, the particles may be applied to the wet surface and cemented thereto. Such particles are preferably spherical, although irregularly shaped particles of substantially uniform size may be used. Short wire segments may also be used as a spacing material.

The fluid traverses the trapping member in a direction substantially normal to the corrugations. The corrugations cause periodic rapid changes in the direction of the fluid and result in the particles dropping out of the fluid stream and being stored on the prepared surfaces of the trap material.

BRIEF STATEMENT OF THE INVENTION

Briefly stated, the present invention is in a co-current trap for continuously separating particulates from a fluid stream. The device comprises a rotatable particle trap member through which the fluid flows, and having upstream and downstream sides. It is mounted for rotation on an axis in substantial alignment with the direction of fluid flow. There is provided a stationary conduit confronting the rotatable trap member on the upstream side and which conduit is isolated from the particle-containing fluid. It is for co-currently directing a regenerating fluid through a portion of said trap during rotation thereof to continuously regenerate the trap by removal of the particles collected therein.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention may be better understood by having reference to the annexed drawings wherein:

Figure 1 is a partial plan view of a corrugated strip from which the trap segments of the present invention are fabricated. The crowns and grooves of the corrugations are desirably parallel to the longitudinal axis of the strip.

Figure 2 is an end view of the corrugated strip shown in Figure 1.

Figure 3 is an isometric view of a plurality of corrugated strip portions in nested spaced relation showing the direction of fluid flow through the member.

Figure 4 is a top plan view of a rotatable member wherein the corrugated strip of Figure 1 is wound in spiral form, and the convolutions are maintained in spaced relation by a particle containing coating on both sides thereof. Also shown in Figure 4 is the regenerating segment of the rotary member, better shown in Figure 8.

Figure 5 shows a top plan view of another form of rotatable member formed from a plurality of frusto-prismatic elements defining a hexagonal insert in a ring adapted to be mounted for rotation.

Figure 6 shows a top plan view of another form of rotatable member.

Figure 7 shows a top plan view of still another form of rotatable member.

Figure 8 is a fragmentary side elevation of an exhaust line insert showing the rotatable member, the adaptors therefor, the drive means for rotating the member, and the stationary regenerating duct for conducting regenerant to the upstream side of the particle trap member.

Figure 9 shows another top plan view of a rotatable member.

Figure 10 is a cross-sectional view taken in the plane indicated by the line 10-10 in Figure 11 showing a wire wool filler for the rotating wheel.

Figure 11 is a cross-sectional view taken in the plane indicated by the line 11-11 in Figure 10.

Figure 12 is a top plan view of another form of rotary particulate trap in accordance herewith using ceramic monoliths as the trapping elements.

Figure 13 is a diametral cross-sectional view of a rotary rap member in accordance with the present invention showing a composite structure, a portion of which is a corrugated metal structure and a portion of which is a wire wool. A perforated plate is provided to maintain the wire wool in place.

Figure 14 is a fragmentary view of a pair of corrugated metallic members in juxtaposition, a portion being of the structure shown in Figure 3, and a portion being filled with wire wool.

DETAILED DESCRIPTION OF THE DRAWINGS

As indicated above, the present device is for removing particulate matter having a particle size generally 1 micron or less, e.g., .01 to 1.0 micron from a flowing fluid stream. Normally, the stream is gaseous although the principles hereof apply as well to liquid streams. The invention will be described from this point forward in relation to gaseous streams containing solid micron and sub-micron size particulate matter, and especially diesel exhaust gases containing carbonaceous particles. The present device is a rotary particle trap. The trap member is a series of corrugated metal portions, preferably formed of stainless steel, held in a closely spaced relation by cementing, for example, or by a retaining ring or other suitable means. The spacing is determined by uniformly sized particles deposited on and adhered to the confronting surfaces of the corrugated metal. In general, these particles have a particle size of from 0.010 to about 0.050 inch, and are quite uniform in size. In other words, the size selection is closely controlled as by screening over a short range of screen sizes. In the course of its rotation the particle trap is exposed to the particle-containing gas for the major part of its rotation, e.g., 60% to 80% of its rotation, and for the balance of its rotation to a regenerating material, e.g., hot air or air and fuel at about 1200F°. As will be explained below, the regenerating zone is defined by a suitable dam or baffle which is stationary relative to the rotating wheel. Thus each segment of the wheel is exposed to the particle containing gas for a major part of its revolution and to the regenerating gas, for example air, or an air-fuel mixture to burn off the carbon, for a minor part of its revolution. The revolving trap

member is, therefore, loaded with particulate and regenerated once each revolution. It will be seen that low rotation speeds lead to higher particle loading and higher regeneration exotherms; high rotation speed gives the opposite effect. Thus, both trap design and rotation speed determine the actual trapping efficiency and maximum temperature of a system for a specific exhaust stream.

The foregoing mode of operation is far simpler and less expensive than the alternating systems of the prior art, and provides a continuous operation without the necessity of a control valve. Although in the preferred case, the size of the regeneration zone is fixed, temperature control may also be accomplished by varying the rate of flow of the regenerating gas, altering the speed of wheel rotation, or by altering the size of the segment exposed to the regenerating gas. Too rapid burning of the accumulated carbon can destroy the apparatus or necessitate the use of costly, high temperature materials.

Referring now more particularly to the drawings, in Figures 1 and 2 there is shown a portion of a corrugated sheet 10 having peaks 12 and valleys 14 in parallel relation to the longitudinal axis of the strip, and similar in appearance to an ordinary corrugated metal or plastic sheet used as a roofing material. This member is, however, desirably formed from stainless steel that is from 0.0015" to about 0.008" thick and preferably about 0.0025" thick. The pitch of the corrugations is generally in the range of from 0.05" to about 0.175", and preferably about 0.085". The depth of the corrugations is about 40% of the pitch, e.g., 0.02" to about 0.070, and preferably about 0.034". When the device is to be used in an exhaust line from a diesel engine, it must be formed of stainless steel because the temperature of regeneration will often be higher than normal exhaust temperature. Any other metal, unless it is an unduly expensive material, will fail under these conditions. Where the device is to be used as a particulate trap in a chemical operation where the temperatures are much lower, other lower temperature withstanding material suitably adhered to the surface may be used as a spacer material.

Figure 3 shows a fragment of a particulate trap member 16 composed of four layers 18, 20, 22, and 24 of the type shown in Figures 1 and 2. The layers 18, 20, 22 and 24 are held in spaced relation by temperature resistant particles of substantially uniform size. In general, these particles have a diameter which is about the same as the corrugation depth, e.g., .02" to .07". Such particles may be stainless steel spheres, or alumina spheres, silica sand or other refractory particles. These particles may be dispersed in a "wash coat" of alumina, alumina gel or mixtures thereof or mechanically

deposited between successive layers. Such "wash coats" are well known in the exhaust catalytic converter art. They define the layer thickness and protrude from the "wash coating" being of larger dimension than the thickness of the wash coat, which is about 0.0002" to 0.005" thick and heated after application to a temperature of about 800° F. for .01 - 0.3 minute to tightly bond the coating and the particles to the corrugated metal, e.g., layer 18. A pigment-volume concentration of less than 10%, and preferably from about 1% to about 3% of the spacer elements 26 in the wash coat is satisfactory. Alternatively, the spacing particles may be mechanically applied.

The "wash coat" also provides a suitable receptor for catalytically active agents such as platinum, palladium, rhodium or mixtures thereof, for converting pollutants such as carbon monoxide, unburned hydrocarbon, NO_x, etc., to environmentally acceptable materials such as CO₂, H₂O, N₂, etc. Thus, the particulate traps hereof may also serve as catalytic converters. A mode for applying a catalyst receptive surface is described in commonly owned application Serial Number 830,698 filed 18 February 1986.

Also, shown in Figure 3 is the direction of the gas flow. It is generally perpendicular to the direction of the corrugations. As the gas flows between the layers of corrugated metal, e.g., layers 18-20, it undergoes rapid changes in direction. This causes the particles carried in suspension in the gas stream to impact and deposit on the surface of the corrugated metal sheet, e.g., layers 18 and 20. The calcined "wash coat" provides a roughened surface to aid in adhesion of the particles, e.g., carbon particles, to the surface. The amount of spacer particles is insufficient to affect materially the flow of the gas through the trap member 16. The free space through the trap member generally ranges from about 90% to about 60%. The juxtaposed corrugated plates for example, 18, 20, 22 (Figure 3) must be properly spaced. If they are too close, the effect is essentially the same as parallel plates. If they are too far apart, the desired trapping effect is greatly diminished and approaches 0. If "s" is considered to be the space between the layers, e.g., layers 18 and 20 in Figure 3 and h is the vertical altitude of the corrugation between the peak and the valley, the best relationship of s to h is expressed by s/h, and in general, s/h 0.2 to 1.2, preferably, from 0.5 to 0.8. Thus, the successive juxtaposed layers are partially nested in the preferred embodiments. We believe, although we do not wish to be bound by any theory of operation, that the particles moving between properly spaced plates, e.g., 18 and 20 in Figure 3, undergo a change in direction and the particles, which tend to continue in a straight path, impact the surface and

adhere thereto.

Figure 4 shows a top plan view of a rotary trap member 40 as it appears in the plane indicated by the line 4-4 in Figure 8. There is provided an outer rim 42 which is dimensioned to contain a spirally wound core 44 formed from a strip of the corrugated thin metal such as shown in Figures 1 and 2. Because of the resistance to coiling, the hub 46 is of relatively large diameter. The hub 46 is a drive member directly attached to a drive motor shown in Figure 8 for rotating engagement with the trap element 40.

Also shown in Figure 4 are the sides 48 and 50 which define the regeneration zone 52. The balance 54 of the rotary member 40 is the trapping zone or collection zone 54. The convolutions, e.g., convolutions 56 and 58, are, as indicated above, maintained in uniformly spaced relation by the interposition of spacing spheres 26 (Figure 3) not shown in Figure 4 and applied to both surfaces of the metal strip as above described. As the rotary member 40 revolves every portion thereof is exposed for a predetermined length of time to the regenerating gas, for example, hot air, and after having the collected carbon burned off, revolution carries the regenerated portion 52 back into the collection zone 54 which is directly exposed to the exhaust gas stream, for further trapping of particles. The sides 48 and 50 are shown at a 45° angle. The magnitude of the regeneration zone must be determined empirically as this dimension will depend upon many factors such as the particulate collection time, the burn off time, foil geometry, fuel used, the size of the engine, the load under which it normally operates, etc. The angle of the sides 48 and 50 will vary, therefore, although in most cases it will fall between 20° and 60°.

Figure 5 shows another form of rotary member 60 having an encircling rim 62. Contained within the rim 62 are six frusto-prismatically shaped, built-up trapping members 64, 66, 68, 70, 72, and 74. In this embodiment, the members, e.g., member 64, is built up of a series of layers, e.g., layers 76, 78, and 80 cut from a straight sheet of corrugated metal, such as shown in Figure 1 and of decreasing length. The several layers, e.g., 76, 78, and 80, may be assembled and welded or cemented together into the desired shape with the spacer elements 26 in place as shown in Figure 3.

Because of the noncircular configuration of the assemblage of elements 64, 66, 68, 70, 72, and 74, the arcuate segments between the rim 62 and the respective elements, e.g., element 64, must be filled with fillets 82, 84, 86, 88, 90, or 92 so that the gases will be forced through the corrugated metal elements, e.g., element 64.

The central hub 94 is configured and dimensioned to occupy the central space defined by the

frusto-prismatic members 64, 66, 68, etc. again to force the gases to pass through the trap elements 64, 66, 68, 70, 72, and 74. The central hub 94 is drivingly engaged with drive means, e.g., the drive motor 312 in Figure 8.

Figure 6 is a top plan view of another embodiment of a rotary trap member 100 having an outer retaining ring 102. A different configuration of the elements is utilized in order to make a more efficient use of a circular member with rectangular trap elements. Thus, there are provided four square trap members 104, 106, 108, and 110 built up in a manner similar to the frusto-prismatic members shown in Figure 5. Intermediate rectangular members 112, 114, 116, and 118 are elongated and lie between the members 104, 106, 108, and 110, respectively, and extend from the central portion 120 to the rim 102. The central portion 120 is a square hub 120 and is directly attached to drive means, e.g., the drive motor 312 shown in Figure 8. Fill-in trap elements 122, 124, 126, 128, 130, 132, 134, and 136 are also of rectangular configuration and partially fill the otherwise free space. In the manner shown above for the trap of Figure 5, there are provided fillets 138, 140, 142, 144, 146, 148, 150, 152, 154, 156, 158, 160, 162, 164, 166, and 168 to force the gases to pass through the trap and regeneration elements.

Figure 7 is an illustration in plan view of yet another embodiment of particulate trap 200 in accordance herewith. In this case, there is shown a set of four square built-up trap elements 202, 204, 206, and 208 confined within a circular rim 210. Gas impermeable members 212, 214, 216 and 218 are disposed between the square trap elements and define at their inner ends a square hole 220 adapted to receive a square drive shaft 222 which is connected to drive means, e.g., the drive motor 312 shown in Figure 8. The open segments between the trap elements 202, 204, 206, and 208 and the rim 210 are filled with suitable gas impermeable fillets 224, 226, 228, and 230. The fillets may be integral with the elongated elements 212, 214, 216, and 218. As before, the fillets are for the purpose of forcing the gases to pass through the trap elements 202, 204, 206, and 208.

Figure 8 shows in partial side elevation, a rotary particulate trap 40, such as shown in Figure 4, mounted for rotation in an exhaust line 300, partially shown. The exhaust line 300 is provided with an inlet adapter 302 and an outlet adapter 304. The inlet adapter 302 is provided with a lip 306 having a diameter larger than the diameter of the rim 42 of the rotary member 40 by an amount sufficient to permit rotation of the rotary member 40, without allowing the escape of gases. Any suitable seal (not shown) may be provided between the lip 306 and the rotary member 40. At the opposite end, the

inlet adapter 302 is reduced in diameter so as to connect to the normal exhaust line, not shown.

The downstream side of the rotary member 40 is fitted with an outlet duct or adapter 304. In like manner, a lip 308 is provided for sealing coaction with the rotary trap member 40 as described above. The outlet adapter 304 is provided with an internal spider 310 attached by any suitable means, e.g., welding, to the wall of the adapter 304 for the purpose of supporting the drive motor 312. The drive motor 312 is preferably a variable speed motor, and may be controlled by computer and related to load, engine speed, particle content, temperature of the exhaust, etc. The motor 312 is provided with a hub 314 adapted to fit into the central portion of the rotary trap member 40 and drivingly engage therewith. Any suitable drive means may be employed to rotate the member 40 including, for example, an external motor and a chain drive (not shown).

Also, shown in Figure 8 is the regenerating duct 316 which is isolated from the exhaust stream by an enclosed chamber 318. An inlet 320 for regenerating gas and leading from the outside of the inlet adapter 302 is provided for conducting regenerating gas into the chamber 302. This is usually hot air or hot inert gas in the case of chemically active particles which it is desired to recover. The regenerating gas flows in the same direction through the trap as the exhaust gas so that the products of regeneration, usually carbon dioxide, are recombined with the exhaust and exit from the system in the usual manner. The regenerating operation is highly exothermic where carbon is the particulate being trapped and careful temperature control is necessary to prevent "burn out" of the rotary trap unit. Temperature monitoring means (not shown) but well known to those skilled in the art are utilized to assure that the temperature within the regenerating zone is properly controlled.

Figure 9 is a preferred form of particulate trap 400 in accordance herewith. In this case, chordal segments 402 of corrugated material are disposed in parallel relation to fill the entire cross-section of the rotary element 400. A rectangular opening 404 is provided for attachment of a suitable drive shaft (not shown) to effect rotation of the trap 400.

While the device described above are quite effective in removing particulates, particularly from diesel engine exhaust, it may be found more effective to provide a foraminous member in the rotatable member to remove submicron particles. The term "foraminous" as used herein means that the passages through the particle trap member are very fine, fluid permeable, and thus capable of entrapping submicron or colloidal solid particles from the fluid stream. Ceramic monoliths, ceramic foam, metal gauze in layers, metal wool tightly

compacted in a given space, etc., may be used as foraminous materials. This invention also contemplates composite trapping elements including both the trapping elements such as shown in Figure 3 and those shown in Figures 10 and 14.

Referring now to Figures 10 and 11, there is here shown in circumferential cross-section (Figure 10) and diametral cross-section (Figure 11) another form of rotary trap in accordance with the present invention. In this case, the trapping material is wire wool or wire gauze. Thus, there is shown in Figure 10, a rotary trap member 500 having a circumferential ring 502 and a hub 504 for attachment of drive means, not shown. The space between the ring 502 and the hub 504 is filled with a wire wool 505, e.g., stainless steel wool, or wire gauze. The filler may be wash coated with alumina and fired, and catalyst(s) for conversion of gaseous pollutants impregnated into the surface, if desired. In order to hold the wire wool in place, perforated circular plates 508 and 510 are provided. These can be welded to the ring 502. The perforated plates 508 and 510 are provided with suitable square openings 504 (Figure 10) for supporting the device 500 on the drive shaft (not shown).

Figure 12 shows another form of rotary trap member 600 having a circular rim 602 and a central hub 604. The trapping elements 606, 608, 610, and 612 are typical ceramic monoliths currently used in conventional diesel traps. In these devices, alternate channels 614 are plugged in order to force the exhaust through the wall of the ceramic filter to abstract very fine particles from the exhaust stream. Filler portions, e.g., portions 616 and 618 are provided to fill in the spaces between the rim 602 and the monoliths, e.g., 608 and 610, and to fill in the space between monoliths, e.g., monoliths 606 and 608, to force the exhaust gas through the ceramic monoliths.

Figure 13 shows in diametral cross-section still another form of rotary trap member 700 in accordance with the present invention. This is a composite device having both the corrugated metal trapping structure which is most effective in trapping larger particle of carbonaceous material, and the metal wool, which is most effective in trapping extremely fine particles of submicron size. Thus, there is shown in Figure 13 a trap member 700 having a circumferential rim 702 and a hub 704 for engagement with a drive shaft (not shown) for effecting rotation of the device. The left hand portion 708 as shown in Figure 13 is formed of corrugated metal, or corrugated metal sections in any suitable form such as the forms shown in Figures 4-7 and 9. The right hand portion 708 is filled with one of the fine particle trapping structures such as shown in Figures 10, 11 and 12, for example stainless steel wool 709. A perforated plate 710 is

provided for holding the wood 709 in the chamber 708.

Figure 14 shows another form of trapping structure 800 of the composite type. Here there are shown two corrugated members 802 and 804 maintained in spaced relation by particles 806 as described in connection with Figure 3. A portion 808 of the space between the corrugated members 802 and 804, e.g., one half the longitudinal space, is filled with a metal wool 810, e.g., stainless steel wool. As indicated above, the wool 810 may be treated so as to have a catalytic conversion effect on gaseous pollutants contained in the exhaust passing therethrough. Likewise, the corrugated section may optionally be treated so as to have both the catalytic conversion effect and the particulate trapping effect.

The structures shown in Figures 10-14 are regenerated during a portion of each revolution in the same manner as described above.

Other configurations of layers and composite structures may be employed and are within the scope of the present invention.

There has thus been provided an improved particulate trap especially suited for trapping carbon particles contained in diesel engine exhaust and which is characterized by continuous trapping and regeneration.

Claims

1. A co-current regeneratable particulate trap for continuously separating particulates from a fluid stream which comprises a rotatable particle trap member having upstream and downstream sides and mounted for rotation on an axis in substantial alignment with the direction of fluid flow and through which said fluid stream flows, and a stationary conduit confronting said rotatable trap member on the upstream side and isolated from said particle-containing fluid for co-currently directing a regenerating fluid through a portion of said rotatable trap member during rotation thereof to continuously regenerate said trap by removal of particles trapped therein.
2. A regeneratable particulate trap as defined in Claim 1 wherein said particles are removed from said trap by oxidation.
3. A regeneratable particulate trap as defined in Claim 1 including means for regulating the speed of rotation of said trap member.
4. A regeneratable particulate trap as defined in Claim 1 including means for controlling the temperature of said regenerating fluid.
5. A regeneratable particulate trap as defined in Claim 1 including means for controlling the composition of the regenerating fluid.
6. A regeneratable particulate trap as defined in Claim 1 wherein the fluid stream is a gas.
7. A regeneratable particulate trap as defined in Claim 6 wherein the gas is exhaust gas from an internal combustion engine.
8. A regeneratable particulate trap as defined in Claim 6 wherein the gas is exhaust gas from a diesel engine.
9. A regeneratable particulate trap as defined in Claim 1 wherein the particulates are carbon particles.
10. A regeneratable particulate trap as defined in Claim 1 wherein the trap comprises a metallic substrate.
11. A regeneratable particulate trap as defined in Claim 10 wherein the metallic substrate is formed from stainless steel.
12. A regeneratable particulate trap as defined in Claim 1 wherein the trap comprises a composite metallic and ceramic substrate.
13. A regeneratable particulate trap as defined in Claim 11 wherein the metallic substrate is formed from stainless steel foil having a thickness of from 0.003 to 0.010 inch.
14. A regeneratable particulate trap as defined in Claim 10 wherein the metallic substrate is corrugated.
15. A regeneratable particulate trap as defined in Claim 13 wherein the foil is corrugated longitudinally of the foil.
16. A regeneratable particulate trap as defined in Claim 13 wherein the foil is provided with a thin wash coat containing alumina.
17. A regeneratable particulate trap as defined in Claim 16 wherein the alumina coat is impregnated with one or more pollutant removing catalysts.
18. A regeneratable particulate trap as defined in Claim 16 wherein the wash coat also contains spacing means dispersed therein for spacing juxtaposed layers of corrugated foil a predetermined distance apart.
19. A regeneratable particulate trap as defined in Claim 18 wherein the spacing means are stainless steel spheres having a predetermined diameter.
20. A regeneratable particulate trap as defined in Claim 18 wherein the spacing means for ceramic spheres having a predetermined diameter.
21. A regeneratable particulate trap as defined in Claim 18 wherein the spacing means are refractory metal oxide particles of a predetermined uniform size.
22. A regeneratable particulate trap as defined in Claim 1 wherein the trap member comprises layers of corrugated sheet metal in juxtaposed relation.

23. A regeneratable particulate trap as defined in Claim 22 wherein the trap member comprises built up segments comprising layers of corrugated sheet metal in juxtaposed relation.

24. A regeneratable particulate trap as defined in Claim 1 wherein the trap member comprises a spirally wound longitudinally corrugated sheet metal strip.

25. A regeneratable particulate trap as defined in Claim 24 wherein successive convolutions of said spirally wound trap member are maintained in spaced relation by hard particles of predetermined size adhered to the confronting surfaces of said convolutions.

26. A trap for continuously separating particulates contained in the exhaust gas of an internal combustion engine which comprises a rotatable trap member having upstream and downstream sides adapted to be placed in intercepting relation with the flow of exhaust gas, said member comprising laminae of partially nested corrugated thin metal foil portions arranged so that the gas flows in a direction normal to the direction of the corrugations, said portions being maintained in predetermined spaced relation by relatively large particles stable in the exhaust environment and having a substantially uniform size and disposed between the surfaces of said portions; and a stationary conduit confronting said rotatable trap member on the upstream side and isolated from said particle-containing exhaust for co-currently directing an oxygen-containing gas optionally containing a fuel, through said rotatable trap member during rotation thereof to regenerate said trap by burning off trapped carbon.

27. A trap for continuously separating particulates as defined in Claim 26 wherein the internal combustion engine is a diesel engine.

28. A trap for continuously separating particulates as defined in Claim 26 wherein the thin metal foil portions are segments of a spirally wound trap body.

29. A trap for continuously separating particulates as defined in Claim 26 wherein the particulates contained in the exhaust comprise carbon.

30. A trap for continuously separating particulates as defined in Claim 26 wherein the surfaces of the corrugated metal foil portions having a coating formed thereon from an alumina-containing wash coat.

31. A trap for continuously separating particulates as defined in Claim 30 wherein the coating also has deposited thereon a catalyst.

32. A trap for continuously separating particulates as defined in Claim 31 wherein the catalyst includes palladium.

33. A trap for continuously separating particulates as defined in Claim 32 wherein the catalyst includes rhodium.

34. A trap for continuously separating particulates as defined in Claim 32 wherein the catalyst includes platinum.

35. A trap for continuously separating particulates as defined in Claim 26 which is further characterized by means for controlling the speed of rotation of said trap member.

36. A trap for continuously separating particulates as defined in Claim 26 which is further characterized by means for controlling the temperature of said oxygen-containing gas.

37. A trap for continuously separating particulates contained in a fluid stream which comprises a rotatable particle trap member comprising a foraminous member adapted to trap submicron sized particles and having upstream and downstream sides, said member being mounted for rotation on an axis in substantial alignment with the direction of fluid flow and through which said fluid stream flows, and a stationary conduit confronting said rotatable trap member on the upstream side and isolated from said particle containing fluid for co-currently directing a regenerating fluid through a portion of said rotatable trap member during rotation thereof to continuously regenerate said trap by removal of particles trapped therein.

38. A regeneratable particulate trap as defined in Claim 37 wherein the foraminous member comprises metal wool.

39. A regeneratable particulate trap as defined in Claim 37 wherein the trap member comprises a corrugated metal portion and a foraminous portion.

40. A regeneratable particulate trap as defined in Claim 39 wherein the metal portion is formed from stainless steel and the foraminous portion is formed of stainless steel wool.

41. A regeneratable particulate trap as defined in Claim 37 wherein the trap member comprises corrugated metal plates in juxtaposed relation and maintained in spaced relation by small uniformly sized particles adhered to the confronting surfaces thereof and defining a fluid passage therebetween, a portion of said fluid passage being filled with a foraminous material.

42. A regeneratable particulate trap as defined in Claim 41 wherein the foraminous material is a metal wool.

43. A regeneratable particulate trap as defined in Claim 42 wherein the metal wool is stainless steel wire wool.

44. A regeneratable particulate trap as defined in Claim 37 which is also characterized by the presence therein of an aluminum oxide coating on the trap member.

45. A regeneratable particulate trap as defined in Claim 44 wherein the aluminum oxide coating has impregnated therein at least one catalyst for converting gaseous pollutant material in the fluid to a harmless gas.

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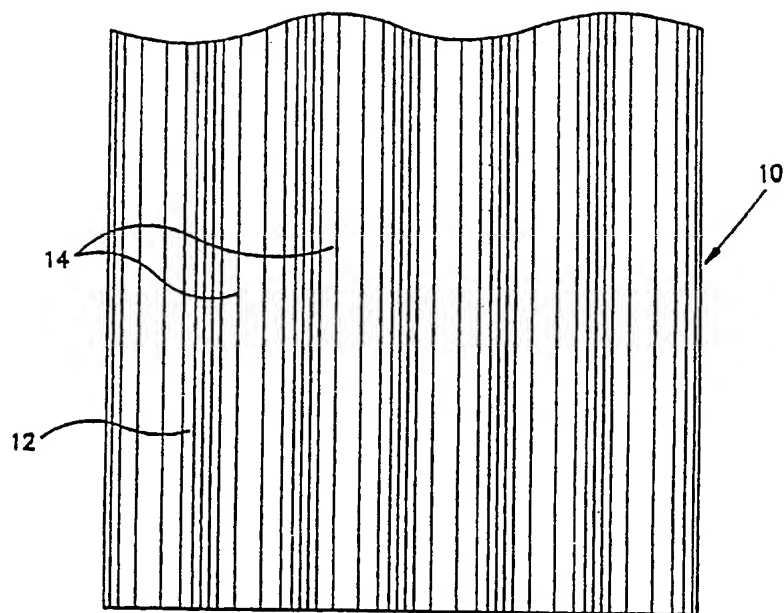


FIG. 1

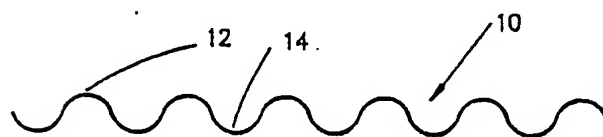


FIG. 2

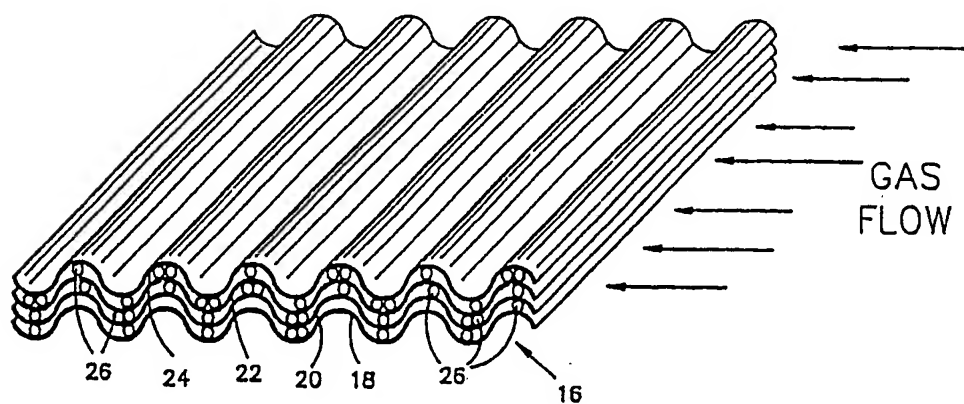


FIG. 3

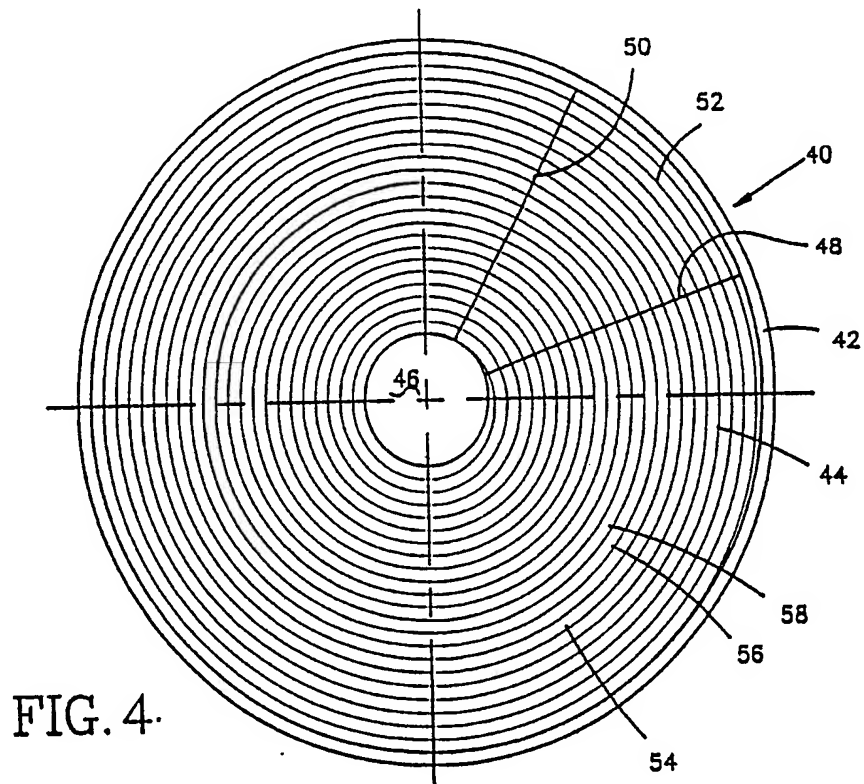


FIG. 4.

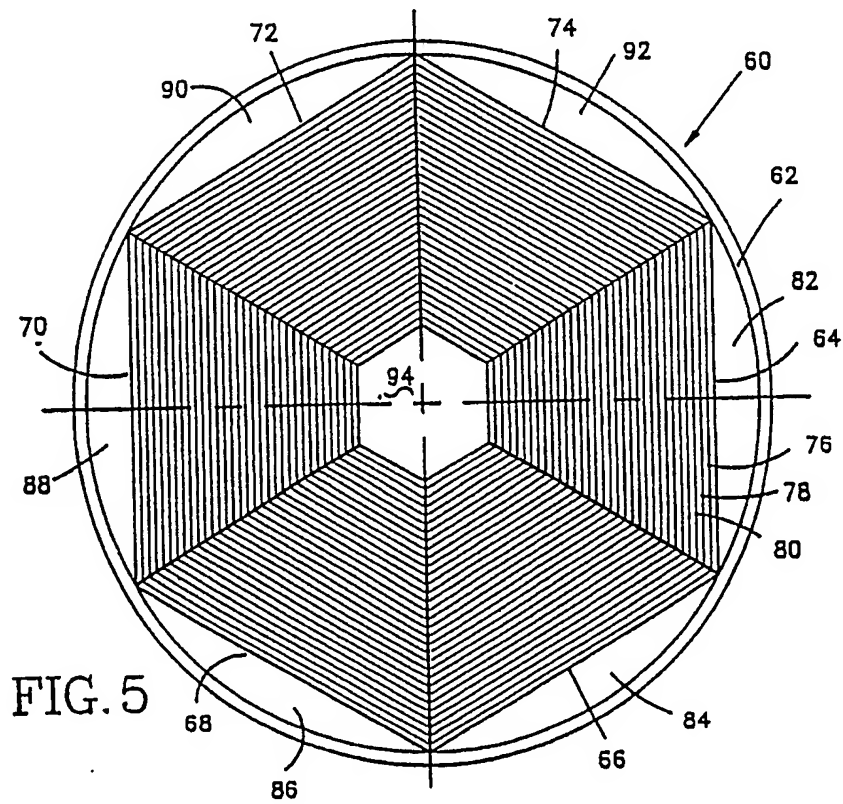
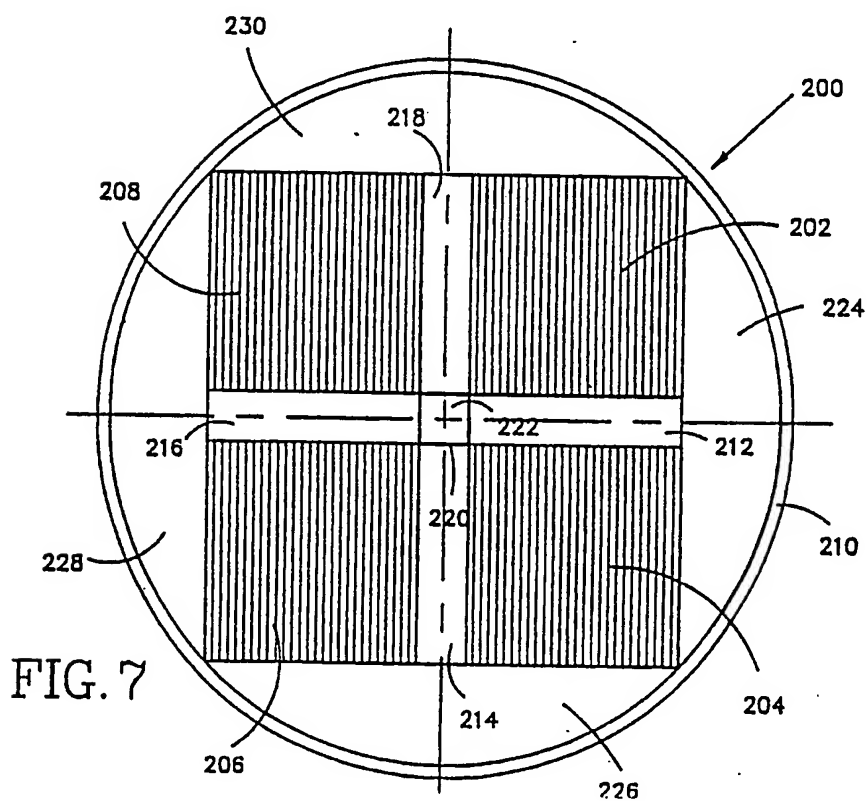
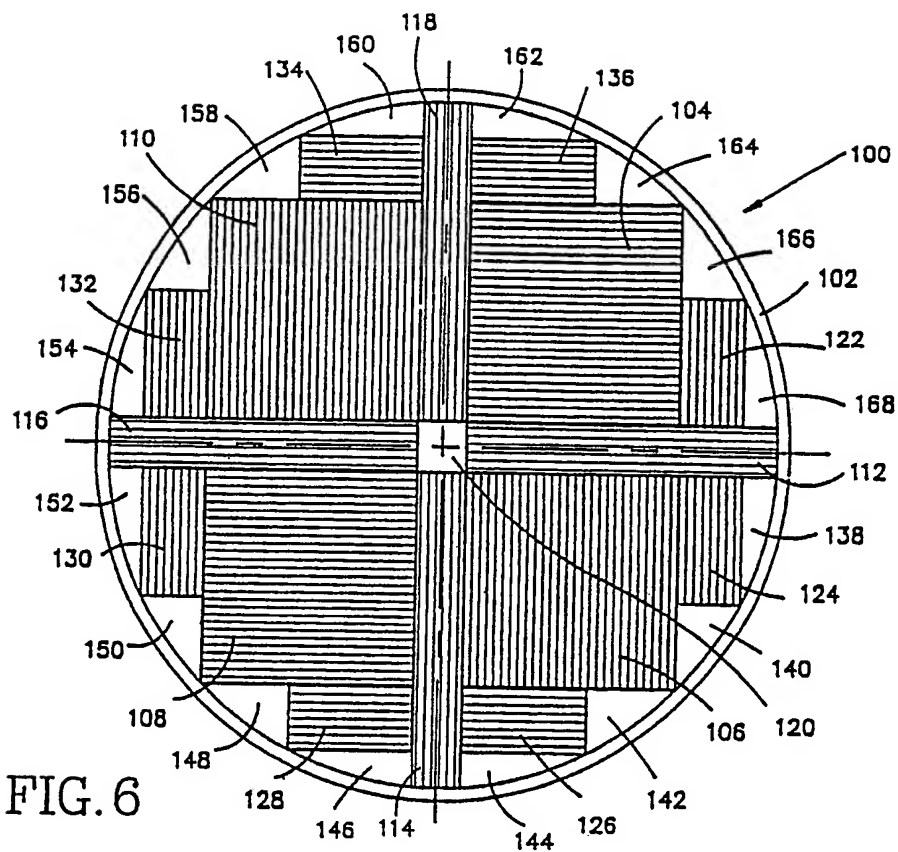


FIG. 5



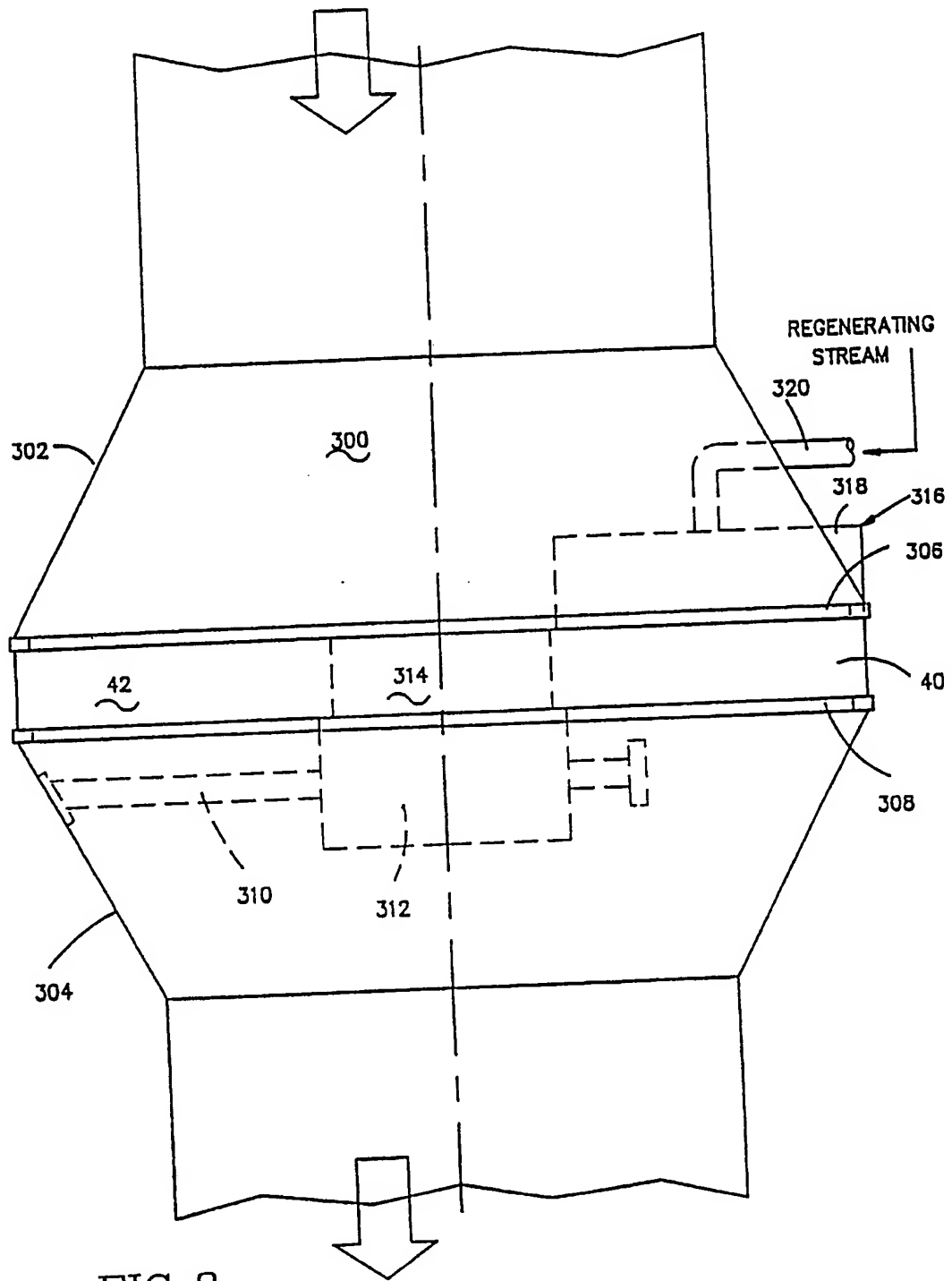


FIG. 8

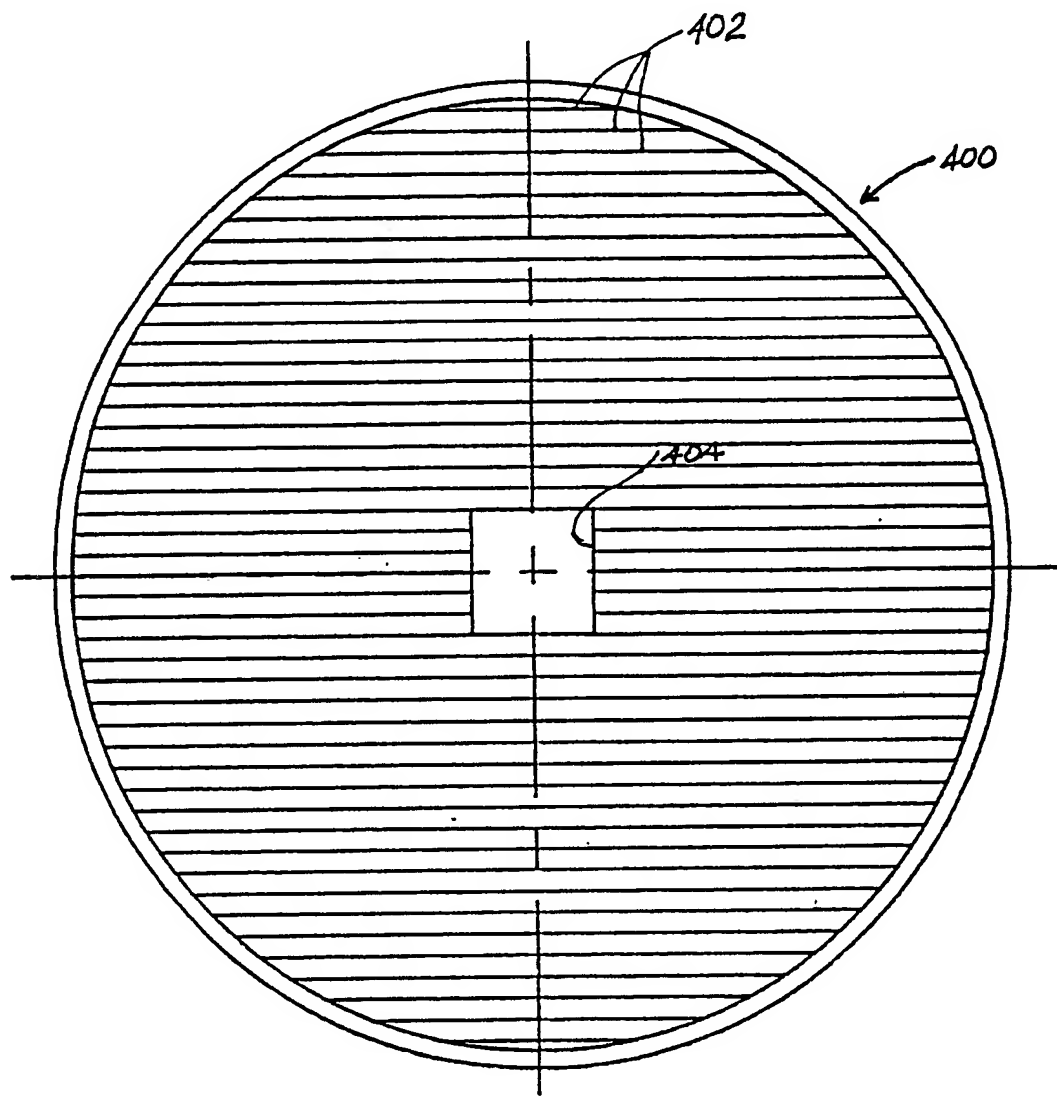


FIG. 9

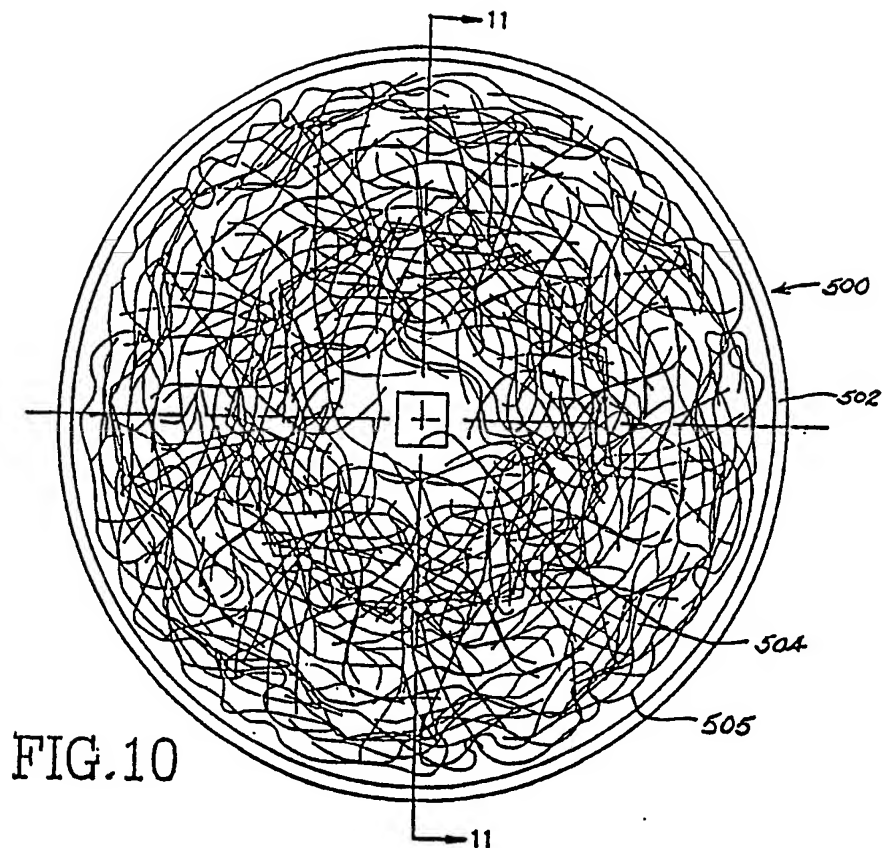


FIG. 10

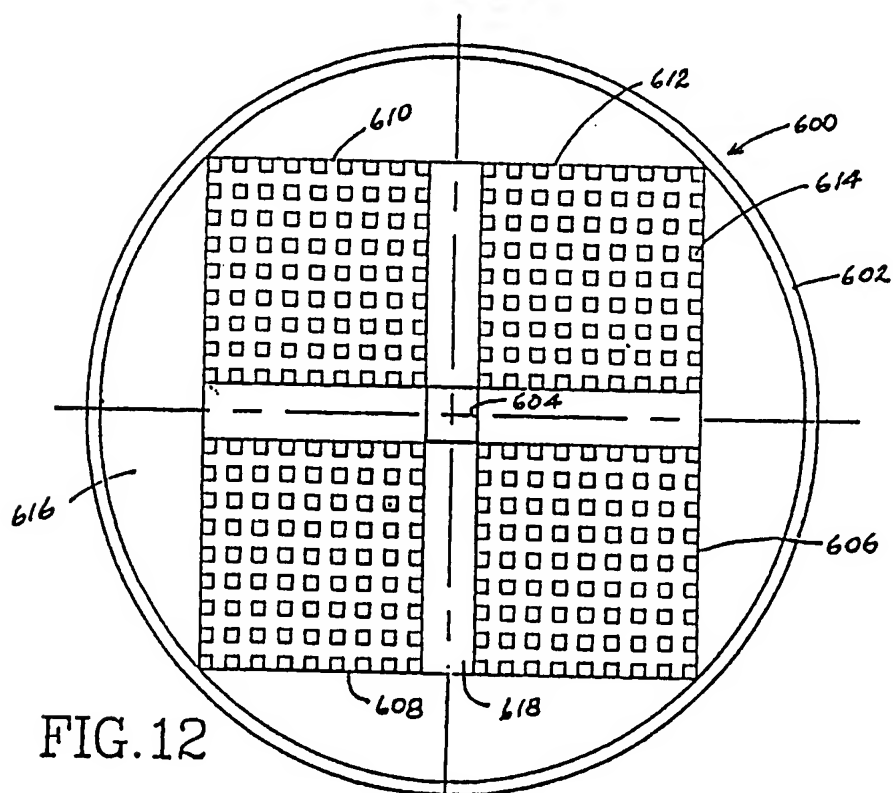


FIG. 12

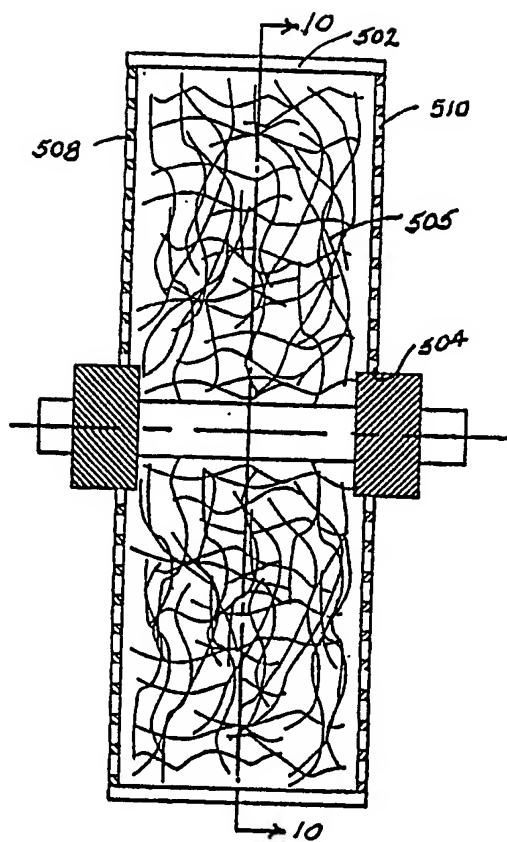


FIG. 11

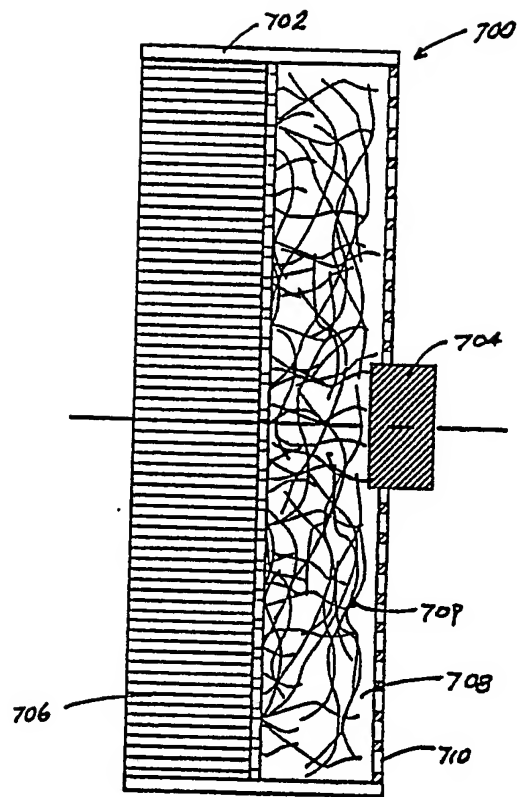


FIG. 13

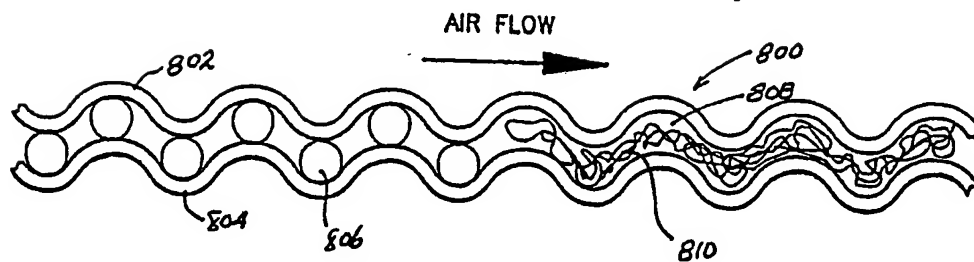


FIG. 14



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number

EP 88 11 3239

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	US-A-4 415 342 (G.D. FOSS) * Column 7, line 57 - column 8, line 4; column 4, line 51 - column 5, line 40; figure 4 *	1-4,6, 10,12, 37,45	B 01 D 46/10 B 01 D 46/12 B 01 D 53/26
A	---	26,35, 36	F 01 N 3/02
X	US-A-4 573 317 (D.A. LUDECKE) * Claim 1; figure 1 *	1,2,6-9 ,45	
A	EP-A-0 222 355 (R. CORNELISON) * Claims 1-5,7,9,11,13-17; figures 2-4 *	1,2,6- 11,13- 17,22, 23,26, 27,29- 34,44,	
A	GB-A-2 065 494 (DEUTSCH GOLD- UND SILBERANSTALT) * Claims 1,2,7,18; page 5, lines 24-29; figures 1,2 *	18,24, 28	
A	US-A-3 948 810 (G.C. HERVERT) * Claims 1-3; figures 1,3,4 *	18,20, 21,25	TECHNICAL FIELDS SEARCHED (Int. Cl.4) B 01 D 46/00 B 01 D 53/00 F 01 N 3/00
A	DE-A-1 953 304 (A. STOKLASEK) * Whole document *	38,39, 40,42, 43	
A	US-A-1 777 957 (K. BÖMCKE) -----		
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 06-09-1988	Examiner POLESAK, H.F.
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document			